Good Practice

Case Study 278

British Telecom maintains office refurbishment improvements as part of its energy management programme

Telephone House
Edinburgh

- Refurbishment led to major savings in building energy costs
- Gas heating costs down by over 40%
- Electricity consumption for lighting beats current good practice target
- Good energy performance sustained by close monitoring and a corporate commitment to energy management

"Energy efficiency improvements from refurbishment and energy management"

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Typical office accommodation showing the extensive use of task lighting

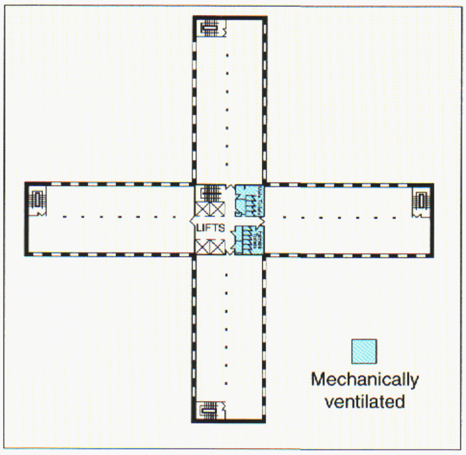

Figure 1 Typical floor plan

Introduction

Telephone House was built in 1973 to provide a telephone exchange and mainly open plan office accommodation for British Telecom (BT). The building was refurbished in the late eighties, and has been successfully managed to sustain reduced energy costs as part of BT's energy management programme.

This Case Study illustrates the savings that can typically be achieved by refurbishing a mid-seventies office building, and continuing to manage it well. BT's corporate commitment to energy efficiency includes major staff awareness campaigns.

The refurbishment provides better conditions for the occupants, computers and associated communications equipment – and greatly reduces building energy costs.

The building has a cruciform plan (see figure 1) with two six-storey and two seven-storey wings extending from a central core, which is surmounted by a central plant room. The 12.5 metre width of the wings makes natural ventilation possible. Mechanical air handling systems are limited to a unit that supplies fresh air to the canteen during meal times and small, self-contained air-conditioning units. The units provide cooling in the computer suite, and in areas where there is a high concentration of VDUs and other office equipment.

As part of the refurbishment, the flat-roof covering needed replacement due to deterioration and the opportunity was taken to upgrade the insulation to current standards. The window U-values were greatly improved by fitting secondary glazing panels inside the original, metal-framed, single glazing.

Other major changes affecting energy costs included replacing most of the lighting system (with higher efficiency luminaires and a mix of automatic and manual controls); and installing a building energy management system (BEMS).

Good energy performance was achieved, and has since been sustained, despite adverse factors such as high usage of office equipment, modest insulation standards, 24-hour operation of some departments, and a large catering facility.

Gas consumption for space and DHW (domestic hot water) heating was reduced by over 40% to 92 kWh/m^2 of treated area: this approximately matches the 'good practice' value, and is less than half the 'typical' value suggested in EEO Energy Consumption Guide 19[1] for naturally-ventilated, mainly open plan office buildings (type 2).

Electricity consumption for lighting is now better than the good practice level[1] for comparable buildings, but the high density of office equipment means that overall electricity consumption (91 kWh/m^2 of treated area, excluding computer suite) is still higher than the Guide's suggested good practice yardstick value of 61 kWh/m^2.

Heating

Two 586 kW conventional, gas-fired boilers, located in the rooftop plant room, deliver hot water via zoned circuits to perimeter convector heaters throughout the building. The entire system is monitored and controlled by the BEMS, which is programmed to allow each office to be heated in accordance with predicted occupancy times. Heat levels are set by room temperature sensors which control diverter valves in the water supply circuit.

A branch distribution circuit provides heating for the canteen's air handling unit, and for convectors in the ground floor reception area.

Domestic hot water

Two 87.6 kW direct-fired gas boilers for DHW supply have replaced the original calorifiers in the rooftop plant room. Another, similar boiler is installed in the ground floor kitchen, and supplies DHW for this area. Neither system uses central hot water storage.

Catering

Electricity and gas are used in kitchen equipment, in a telephone operator's rest room catering facility, and in drinks vending machines that are located throughout the building.

Lighting

The building shape allows daylight to most areas. Artificial lighting in the office accommodation is mainly by recessed twin and quadruple fluorescent tubes, complemented by compact fluorescent downlighter units and desk lamps under individual control.

These units usually provide adequate lighting by themselves, allowing main area lighting to be left off altogether. Central access areas in most offices, and all toilets, have compact fluorescent downlighter units.

Building energy management system

A BEMS, installed during the refurbishment, monitors and largely controls all heating, cooling and mechanical ventilation systems in Telephone House – it also monitors systems in other BT buildings in Scotland.

There are weather-compensated daily heating programmes for 29 zones, and data handling programmes allow detection of trends through quick analysis of monitored information.

Mechanical ventilation and air-conditioning

The ventilation system which serves the dining room has a heater battery to warm the incoming fresh air, served by low pressure hot water from the space heating system.

The computer suite, and areas where solar and office equipment heat gains are highest, are cooled by small, self-contained air-conditioning units. Elsewhere, cooling and natural ventilation is achieved by manually opening the windows.

Analysis of energy consumption and cost

Figure 2 shows a breakdown of annual energy use and costs, based on monitoring from October 1990 to September 1991 (2526 degree-days). During that time, the building consumed about 978 000 kWh of gas and 1.4 million kWh of electricity, costing £10 232 and £66 704 respectively. About 31% of total electricity is used in the computer room, leaving a balance for offices of 961 940 kWh.

The total energy consumption for the building is slightly in excess of 'good practice' levels[1]. This is mainly due to the extensive use of small power loads for office equipment – which has

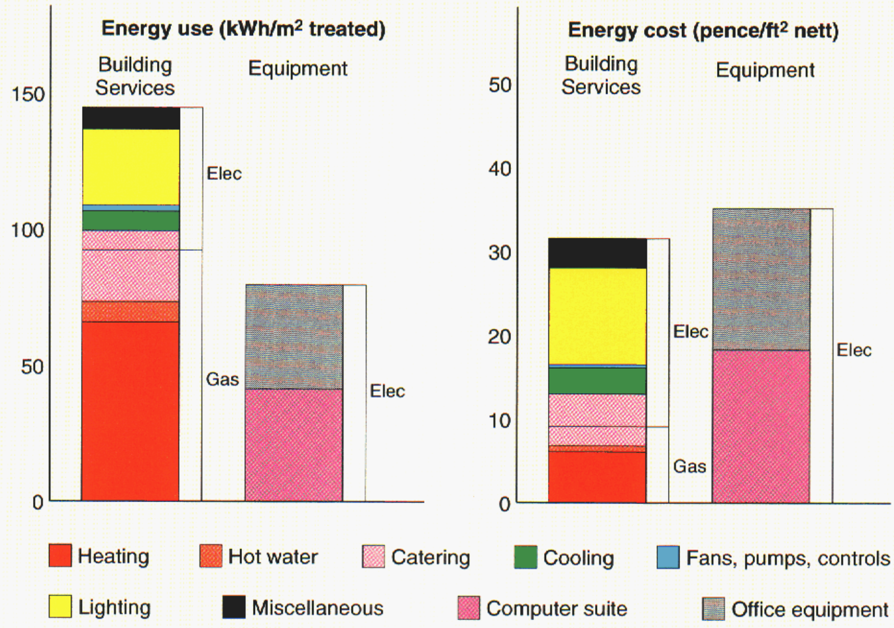

Figure 2 Annual energy use and cost for Telephone House, Edinburgh

Refurbishment building team architect:
Covel Matthew Partnership

Heating and ventilating contractor:
James Scott Ltd

Energy manager:
Arthur Nicholson

Suppliers
There may be other suppliers of similar energy efficient equipment in the market.

Building details
Purpose-built office and telephone exchange accommodation, completed in 1973 and refurbished in 1988.

Floors:	6 and 7
Gross floor area:	10 912 m²
Treated floor area:	10 608 m²
Nett floor area:	8462 m²
Computer suite (included in above):	60 m²
Typical number of occupants:	550
Typical hours of use:	0800 to 1800 weekdays

(Some areas, eg computer suite, are always occupied)

Fabric U-values following refurbishment (W/m²K)

Walls (brick-cavity-concrete block, uninsulated):	1.6
Roof (including suspended ceiling and insulation):	0.45
Windows (metal sliding frames with sliding secondary glazing and internal blinds):	2.9

References

[1] Energy efficiency in offices. A technical guide for owners and single tenants, Energy Consumption Guide 19, London, EEO, 1991.

[2] Natural ventilation in non-domestic buildings. BRE Digest 399. 1994.

resulted in a microcomputer on every desk. However, the gas consumption is considerably better than 'typical' offices of this type, and the electricity use is comparable.

Heating — 66.0 kWh/m² (6.1 p/sq ft)

Heating energy use is very low despite only a moderate standard of building insulation and 24-hour operation of some departments. This is due to the application of appropriate controls to suit the high internal equipment heat gains.

Hot water — 7.4 kWh/m² (0.7 p/sq ft)

Hot water energy use is small for a building of this size with catering kitchens and distribution mains operational throughout the year. The absence of a central hot water storage facility (with associated standing heat losses) is a major contributory factor.

Office equipment — 38.2 kWh/m² (16.8 p/sq ft)

This high figure is largely attributable to desktop computers, printers, plotters and copiers, as well as desk lighting and personal fans, etc. There is approximately one PC or terminal for every person and this is unlikely to change in the near future.

Many of these units are continually switched on. The building is open 24 hours a day for shift work, therefore computers are used for 24 hours.

The office equipment is mostly evenly distributed about the building, although some areas have a higher concentration and can experience excessively high space temperatures during warmer weather.

These areas have been equipped with local packaged air-conditioning units which results in an increase in energy consumption.

Catering — 26.0 kWh/m² (2.3 p/sq ft gas and 3.9 p/sq ft electric)

The gas figure (18.9 kWh/m²) and electricity (7.1 kWh/m²) are high in comparison with other offices. This is largely due to the extensive hours of occupancy of the building and the availability of hot meals and snacks, six days per week.

Cooling — 7.1 kWh/m² (3.1 p/sq ft)

The cooling load has increased significantly along with the growing amount of office equipment during the life of the building, and cooling equipment has been required in areas of high concentration of VDU terminals, etc.

Fans and pumps — 2.2 kWh/m² (0.4 p/sq ft)

Energy consumption is low for the size of building and reflects the modest extent of systems installed.

Lighting **28.0 kWh/m² (11.5 p/sq ft)**

An efficient lighting design, together with effective use of the automatic control system achieves a consumption below best practice level.

Miscellaneous **8.0 kWh/m² (3.5 p/sq ft)**

This is made up of vacuum cleaners, maintenance equipment and lifts, telecoms and toilet hand driers.

User reactions

The installation of openable secondary glazing was originally motivated by staff complaints of draughty windows. Reduced energy consumption resulted from these improvements to occupants' comfort. Limited areas of high occupant and computer density were dealt with by mechanical ventilation. Initial adverse reaction to the new lighting control system has been tempered by familiarity of use. Interestingly, this has an energy saving side-effect where there are desk or task lights. The use of these is generally preferred to the main lighting and these smaller lights have a rating of 15 W, opposed to 112 W for a typical luminaire.

General appraisal

In the completion of the refurbishment, the Energy Manager and his staff have succeeded in creating a well-controlled building with annual heating and hot water costs of 73p per square metre of treated area. All of these improvements are sustained by BT's corporate commitment to energy management.

Compensated zone control of the heating and the ability to isolate sections within each zone remotely by the BEMS has proved to be very successful. The zoning and associated programmers with flexible schedules have combined to avoid the previous need for the whole building to be heated at all times. The modest insulation standard of the building has been improved in a cost-effective manner and allows the heating system to provide adequate comfort conditions with a low energy expenditure. A large proportion of the heating energy required is provided by equipment heat gains and the BEMS is effective in ensuring that areas do not overheat.

Downlighters to central core areas

The addition of secondary glazing has improved the building's insulation and comfort standards for a modest investment. The floor to ceiling height of 2.4 m with a plan width of 12.5 m are within good practice limits for natural ventilation. BRE Digest 399[2] confirms that this width to height (ratio 5:1) approximates the rule of thumb for cross-ventilating buildings with moderate to high heat gains.

Economical lighting is achieved by installing efficient luminaires and lamps throughout the building. This low installed power load is augmented by manual and automatic controls, and good management.

Table 1 compares the total electricity and gas use with typical figures for a medium-sized, Type 2, naturally-ventilated, open plan building (Energy Consumption Guide 19[1]). It also shows the implied savings translated into reduction of CO_2 emissions.

The total CO_2 savings of 19 kg/m² represent an annual saving for the office of 201 552 kg.

Main conclusions

The low energy consumption for heating has been achieved in spite of the fact that the thermal characteristics of the 1970s structure are relatively poor. The effectiveness of zone controls to take full advantage of internal heat gains has been a major factor in this performance.

At Telephone House the common and wasteful practice of opening windows to alleviate overheating has been avoided. The installation of secondary glazing has been successful in terms of energy efficiency and improving occupant comfort.

However, the main reason for the continuing success of all the measures outlined in this Case Study is dedicated energy management on the part of BT.

Short notes on the measurement of floor area

Gross — Total building area measured inside external walls.

Nett — Gross area less common areas and ancillary spaces. Agent's lettable floor area.

Treated — Gross area less plant rooms and other areas (eg stores), not directly heated.

Precise definitions are available on request

	Energy (kWh/m² treated)			**CO_2 savings** kg/m²
	Telephone House	**Typical naturally ventilated office**	**Reduction**	
Gas	90	200	110	23
Electricity	91	85	(+6)	(+4)

Table 1 Energy use and carbon dioxide savings (corrected for degree-days)

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Printed in the UK for HMSO. Dd.8439874, 5/95, C50, 38938

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